DESCRIPTION

FLAT TUBE MAKING PLATELIKE BODY, FLAT TUBE, HEAT EXCHANGER AND PROCESS FOR FABRICATING HEAT EXCHANGER

CROSS REFERENCE TO RELATED APPLICATION

This application is an application filed under 35 U.S.C. §111(a) claiming the benefit pursuant to 35 U.S.C. §119(e)(1) of the filing date of Provisional Application No. 60/559,950 filed April 7, 2004 pursuant to 35 U.S.C. §111(b).

TECHNICAL FIELD

The present invention relates to platelike bodies useful for making flat tubes for use as heat exchange tubes for heat exchangers, such as refrigerant tubes in condensers or evaporators for motor vehicle air conditioners, oil tubes for motor vehicle oil coolers, water tubes for motor vehicle radiators and heat medium tubes for heater cores, flat tubes, heat exchangers comprising such flat tubes and a process for fabricating the exchanger.

The term "aluminum" as used herein and in the appended claims includes aluminum alloys in addition to pure aluminum.

BACKGROUND ART

In recent years, widely used in motor vehicle air conditioners in place of conventional serpentine condensers are condensers wherein, for example, chlorofluorocarbon refrigerant is used and which comprise, as shown in FIG. 13,

a pair of headers 50, 51 arranged in parallel and spaced apart from each other, parallel flat refrigerant tubes 52 made of aluminum and each joined at its opposite ends to the two headers 50, 51, corrugated aluminum fins 53 each disposed in an air flow clearance between each adjacent pair of refrigerant tubes 52 and brazed to the adjacent tubes 52, an inlet pipe 54 connected to the upper end of peripheral wall of the first 50 of the headers, an outlet pipe 55 connected to the lower end of peripheral wall of the second 51 of the headers, a first partition 56 provided inside the first header 50 and positioned above the midportion thereof, and a second partition 57 provided inside the second header 51 and positioned below the midportion thereof. The number of refrigerant tubes 52 positioned above the first partition 56, the number of refrigerant tubes 52 between the first partition 56 and the second partition 57 and the number of refrigerant tubes 52 positioned below the second partition 57 decrease from above downward to provide groups of channels. A refrigerant flowing into the inlet pipe 54 in a vapor phase flows zigzag through units of channel groups in the condenser before flowing out from the outlet pipe 55 in a liquid phase. The condensers of the construction described are called multiflow condensers, and realize high efficiencies, lower pressure losses and supercompactness.

It is required that the refrigerant tube 52 of the condenser described be excellent in heat exchange efficiency and have pressure resistance since the gaseous refrigerant of high pressure is introduced thereinto. Moreover, the tube needs to be small in wall thickness and low in height so as to make

the condenser compact.

For example, the publication of JP-A No. 2003-53460 discloses a known flat tube which is excellent in heat exchange efficiency for use as such a refrigerant tube 52. The flat tube disclosed in the publication comprises a pair of flat walls opposed to each other, opposite side walls interconnecting respective opposed pairs of side edges of the flat walls, and a plurality of reinforcing walls interconnecting the pair of flat walls, extending longitudinally of the tube and spaced from one another by a predetermined distance, the flat tube having a plurality of parallel fluid channels in its interior. Each of the reinforcing walls is made from wall forming portions inwardly upstanding from one of the flat walls and formed integrally therewith and wall forming portions inwardly upstanding from the other flat wall and formed integrally therewith by brazing each corresponding pair of wall forming portions as butted against each other.

Such a flat tube is fabricated from a platelike body in the form of a single metal plate in its entirety and having two flat wall forming portions of same width for making the two flat walls, a connecting portion interconnecting the flat wall forming portions for making one of the side walls a side wall forming portion formed on each flat wall forming portion integrally therewith and projecting from one side edge thereof opposite to the connecting portion for making the other side wall, and a plurality of reinforcing wall forming portions projecting from each flat wall forming portion integrally therewith, by bending the platelike body into the

shape of a hairpin at the connecting portion, brazing the side wall forming portions as butted against each other and brazing each reinforcing wall forming portion on one of the flat wall forming portions to the corresponding reinforcing wall forming portion on the other wall forming portion as butted thereagainst.

However, the flat tube making platelike body disclosed in the above publication is found to have the following problem because the corresponding pair of reinforcing wall forming portions on the flat wall forming portions are equal in thickness. The brazing operation for making the flat tube causes the shrinkage of the brazing material, with the result that as shown in FIG. 14, a fillet 62 is formed only between the opposed end faces of the pair of reinforcing wall forming portions 60, 61 after brazing, and is constricted as indicated at 63. This impairs the strength of the brazing joint between the reinforcing wall forming portions 60, 61 to lower the pressure resistance of the flat tube made. Although it appear useful to make the refrigerant tube, for example, 16 mm in width, 1.1 mm in height and up to about 0.5 mm in the wall thickness of the reinforcing wall forming portions in order to provide a compacted condenser, the above problem becomes pronounced in such a case.

An object of the present invention is to overcome the above problem and provide a flat tube making platelike body which is capable of giving an increased strength to the brazing joint between each corresponding pair of reinforcing wall forming portions and improved pressure resistance to the flat tube

to be fabricated.

DISCLOSURE OF THE INVENTION

To fulfill the above object, the present invention comprises the following modes.

1) A flat tube making platelike body in the form of a single metal plate in its entirety and comprising two flat wall forming portions having the same width and interconnected by a connecting portion, side wall forming portions projecting from the respective flat wall forming portions toward the same direction and each formed integrally with one side edge of the flat wall forming portion opposite to the connecting portion, the side wall forming portions being butted against each other when metal plate is folded into a hairpin form at the connecting portion, and a reinforcing wall forming portion integrally formed on each of the flat wall forming portions so as to project in the same direction as the side wall forming portion thereon, the reinforcing wall forming portion of one of the flat wall forming portions being butted against that of the other flat wall forming portion as a pair when the metal plate is folded into a hairpin form at the connecting portion, one of the pair of reinforcing wall forming portions to be butted against each other being smaller in thickness than the other reinforcing wall forming portion.

2) A flat tube making platelike body according to par. 1) wherein a thin reinforcing wall forming portion and a thick reinforcing wall forming portion are provided on each of the flat wall forming portions integrally therewith.

3) A flat tube making platelike body according to par. 2) wherein each of the flat wall forming portions is integrally provided with thin reinforcing wall forming portions and thick reinforcing wall forming portions arranged alternately thereon.

4) A flat tube making platelike body according to par. 1) wherein the thin reinforcing wall forming portion is up to 0.5 mm in thickness.

5) A flat tube making platelike body according to par. 4) wherein the thin reinforcing wall forming portion is up to 0.35 mm in thickness.

6) A flat tube making platelike body according to par. 1) wherein the difference between the thickness of the thin reinforcing wall forming portion and the thickness of the thick reinforcing wall forming portion is at least 0.05 mm.

7) A flat tube making platelike body according to par. 6) wherein the difference between the thickness of the thin reinforcing wall forming portion and the thickness of the thick reinforcing wall forming portion is up to 0.3 mm.

8) A flat tube making platelike body according to par. 1) wherein when the pair of reinforcing wall forming portions are butted against each other by folding the metal plate into a hairpin form at the connecting portion, opposite side faces of the thin reinforcing wall forming portion are positioned inwardly of opposite side faces of the thick reinforcing wall forming portion.

9) A flat tube making platelike body according to par. 1) wherein an end face of one of the pair of reinforcing wall

forming portions to be butted against each other is provided at an intermediate portion of width thereof with a ridge extending longitudinally thereof, and the other reinforcing wall forming portion is provided in an end face thereof with a groove extending longitudinally thereof for the ridge to fit in.

10) A flat tube making platelike body according to par. 9) wherein the ridge is formed on an end face of the thin reinforcing wall forming portion, and the groove is formed in an end face of the thick reinforcing wall forming portion.

11) A flat tube making platelike body according to par. 1) wherein an end face of the thick reinforcing wall forming portion is provided in the center of width thereof with a groove extending longitudinally of the thick reinforcing wall forming portion.

12) A flat tube making platelike body according to par. 1) wherein the thick reinforcing wall forming portion is provided in an end face thereof with a groove extending longitudinally of the thick reinforcing wall forming portion for an end of the thin reinforcing wall forming portion to fit in.

13) A flat tube fabricated from a flat tube making platelike body according to par. 1) by folding the platelike body into a hairpin form at the connecting portion to butt the side wall forming portions against each other and the pair of reinforcing wall forming portions against each other, and brazing the side wall forming portions to each other and the pair of reinforcing wall forming portions to each other in this state to cause the two flat wall forming portions to

provide a pair of opposed flat walls, the connecting portion to provide one side wall, the side wall forming portions as brazed to each other to provide the other side wall, and the brazed pair of reinforcing wall forming portions to provide a reinforcing wall.

14) A flat tube according to par. 13) wherein opposite side faces of the thin reinforcing wall forming portion are positioned inwardly of opposite side faces of the thick reinforcing wall forming portion, and a fillet is formed between opposed end faces of the pair of reinforcing wall forming portions and between opposite side edges of end face of the thin reinforcing wall forming portion and opposite side edges of end face of the thick reinforcing wall forming portion.

15) A flat tube fabricated from a flat tube making platelike body according to par. 12) by folding the platelike body into a hairpin form at the connecting portion to butt the side wall forming portions against each other and the pair of reinforcing wall forming portions against each other, and to fit the end of the thin reinforcing wall forming portion into the groove of the thick reinforcing wall forming portion, and brazing the side wall forming portions to each other and the pair of reinforcing wall forming portions to each other in this state to cause the two flat wall forming portions to provide a pair of opposed flat walls, the connecting portion to provide one side wall, the side wall forming portions as brazed to each other to provide the other side wall, and the brazed pair of reinforcing wall forming portions to provide a reinforcing wall.

16) A flat tube according to par. 15) wherein a fillet is formed between an end face of the thin reinforcing wall forming portion and a bottom wall of the groove of the thick reinforcing wall forming portion, and between opposite side faces of a portion existing outside the groove of the thin reinforcing wall forming portion and opposite side edges of end face of the thick reinforcing wall forming portion.

17) A heat exchanger comprising pair of headers arranged in parallel as spaced apart from each other, a plurality of heat exchange tubes each comprising a flat tube according to par. 13) or 15) and having opposite ends joined to the respective headers, and fins arranged in respective air passing clearances between respective adjacent pairs of heat exchange tubes and each brazed to the pair of heat exchange tubes adjacent thereto.

18) A process for fabricating a heat exchanger characterized by making a plurality of folded bodies from flat tube making platelike bodies according to any one of pars. 1) to 12) by folding each of the platelike bodies into a hairpin form to butt the side wall forming portions against each other and the pair of reinforcing wall forming portions against each other, preparing a pair of headers each having folded body inserting holes arranged at a spacing and fins, arranging the pair of headers as spaced apart from each other and arranging the folded bodies and the fins alternately, inserting opposite ends of the folded bodies into the respective inserting holes of the headers, fabricating flat tubes by brazing the side wall forming portions of each folded body to each other and the pair of reinforcing wall forming portions thereof to each

other, and brazing the flat tubes to the headers and each fin to the flat tubes adjacent thereto simultaneously with the fabrication of the flat tubes.

19) A refrigeration cycle comprising a compressor, a condenser, an evaporator and a pressure reducing device for use with a chlorofluorocarbon refrigerant, the condenser comprising a heat exchanger according to par. 17).

20) A refrigeration cycle comprising a compressor, a condenser, an evaporator and a pressure reducing device for use with a chlorofluorocarbon refrigerant, the evaporator comprising a heat exchanger according to par. 17)

21) A supercritical refrigeration cycle which comprises a compressor, a gas cooler, an evaporator, a pressure reducing device and an intermediate heat exchanger for subjecting a refrigerant flowing out of the gas cooler and a refrigerant flowing out of the evaporator to heat exchange, and wherein a supercritical refrigerant is used, the gas cooler comprising a heat exchanger according to par. 17).

22) A supercritical refrigeration cycle which comprises a compressor, a gas cooler, an evaporator, a pressure reducing device and an intermediate heat exchanger for subjecting a refrigerant flowing out of the gas cooler and a refrigerant flowing out of the evaporator to heat exchange, and wherein a supercritical refrigerant is used, the evaporator comprising a heat exchanger according to par. 17).

23) A vehicle having installed therein a refrigeration cycle according to par. 19) as a vehicle air conditioner.

24) A vehicle having installed therein a refrigeration

cycle according to par. 20) as a vehicle air conditioner.

25) A vehicle having installed therein a refrigeration cycle according to par. 21) as a vehicle air conditioner.

26) A vehicle having installed therein a refrigeration cycle according to par. 22) as a vehicle air conditioner.

With the flat tube making platelike body described in par. 1), one of the pair of reinforcing wall forming portions to be butted against each other is given a smaller thickness than the other reinforcing wall forming portion, so that when the metal plate is folded into a hairpin form at the connecting portion to butt these portions against each other, at least one side face of the thin reinforcing wall forming portion is positioned inwardly of the side face of the thick reinforcing wall forming portion. When the two reinforcing wall forming portions are brazed to each other in fabricating a flat tube, therefore, a fillet will be formed between the end faces of the two reinforcing wall forming portions and between at least one side face edge of the end face of the thin portion and the edge of the end face of the thick portion positioned outwardly of the thin portion. This prevents the formation of constriction in the fillet. Consequently, the brazing joint strength of the two reinforcing wall forming portions is greater than the brazing joint strength of the flat tube fabricated using the platelike body disclosed in the foregoing publication, giving improved pressure resistance to the flat tube.

With the flat tube making platelike body described in pars. 2) and 3), the two flat wall forming portions, side wall forming portions and reinforcing wall forming portions

may be formed on a metal plate integrally therewith, for example, by rolling the sheet. The material then exhibits improved flowability, giving the side wall forming portions and the reinforcing wall forming portions improved dimensional accuracy.

When the platelike body according to pars. 4) and 5) is used, the flat tube to be fabricated can be made compacted and lightweight, consequently making the heat exchanger compact and lightweight in its entirety when incorporating such flat tubes.

The use of the flat tube making platelike body described in par. 6) ensures the advantage of giving an enhanced brazing joint strength to the two reinforcing wall forming portions and improved pressure resistance to the flat tube already described with reference to par. 1).

The flat tube making platelike body according to par. 7) prevents the increase in the weight of the flat tube to be fabricated since it is not particularly required to greatly increase the thickness of the thick reinforcing wall forming portion.

When the butted pair of reinforcing wall forming portions are brazed in fabricating a flat tube using the platelike body described in par. 8), a fillet will be formed between the end faces of the reinforcing wall forming portions and between the side edges of end face of the thin portion and side edges of end face of the thick portion, whereby formation of constriction is avoidable between the end faces of the two portions. This results in the great advantage of giving an

enhanced brazing joint strength to the two reinforcing wall forming portions and improved pressure resistance to the flat tube.

When the platelike body described in par. 9) is used, the two reinforcing wall forming portions can be given an increased area of brazing between the two reinforcing wall forming portions, entailing the greater advantage of giving an increased brazing joint strength to the two portions and further improved pressure resistance to the flat tube as already described with reference to par. 1).

The advantage described with reference to par. 10) is available to a greater extent with the platelike body according to par. 9).

When the platelike body described in par. 11) is used, the two reinforcing wall forming portions can be given an increased area of brazing between the two reinforcing wall forming portions, entailing the greater advantage of giving an increased brazing joint strength to the two portions and further improved pressure resistance to the flat tube as already described with reference to par. 1).

When the platelike body described in par. 12) is used, the two reinforcing wall forming portions can be given an increased area of brazing between the two reinforcing wall forming portions, entailing the greater advantage of giving an increased brazing joint strength to the two portions and further improved pressure resistance to the flat tube as already described with reference to par. 1).

The flat tube according to par. 13) and 16) has enhanced

brazing joint strength between the two reinforcing wall forming portions, and tube is therefore given improved pressure resistance.

In the case of the heat exchanger according to par. 17), the flat tubes can be given sufficient pressure resistance even if diminished in weight or size. This renders the heat exchanger smaller in size and lightweight in its entirety

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view showing an embodiment of flat tube. FIG. 2 is an enlarged fragmentary view of FIG. 1. FIG. 3 is a diagram showing some steps of a process for fabricating the flat tube of FIG. 1 from a platelike body. FIG. 4 is a sectional view showing the main portion of FIG. 3(c) on an enlarged scale. FIG. 5 is a cross sectional view showing another embodiment of flat tube. FIG. 6 is a front view showing a platelike body for making the flat tube shown in FIG. 5. FIG. 7 is a cross sectional view showing another embodiment of flat tube. FIG. 8 is an enlarged fragmentary view of FIG. 7. FIG. 9 is a front view showing a platelike body for making the flat tube shown in FIG. 7. FIG. 10 is a cross sectional view showing on an enlarged scale first and second reinforcing wall forming portions of the platelike body shown in FIG. 9. FIG. 11(a) is a view corresponding to FIG. 4 and showing modified first and second reinforcing wall forming portions. FIG. 11(b) is a fragmentary sectional view showing a flat tube fabricated from a platelike body having the first and second reinforcing wall forming portions of FIG.

11(a). FIG. 12(a) is a view corresponding to FIG. 4 and showing another modification of first and second reinforcing wall portions. FIG. 12(b) is a fragmentary sectional view showing a flat tube fabricated from a platelike body having the first and second reinforcing wall forming portions of FIG. 12(a). FIG. FIG. 13 is a perspective view showing a condenser for use in motor vehicle air conditioners. FIG. 14 is a fragmentary sectional view showing a flat tube fabricated from a conventional platelike body.

BEST MODE OF CARRYING OUT THE INVENTION

Embodiments of the present invention will be described below with reference to the drawings. In the following description, the upper and lower sides, and the left- and right-hand sides of FIG. 1 will be referred to as "upper," "lower," "left" and "right," respectively. Throughout the drawings, like parts will be designated by like reference numerals.

FIG. 1 shows a flat tube, FIG. 2 is a fragmentary view of the flat tube, FIG. 3 shows some steps of a process for fabricating the flat tube using a platelike body, and FIG. 4 is a fragmentary view of FIG. 3(c).

With reference to FIG. 1, the flat tube 1 is made of aluminum and comprises an upper and a lower flat wall 2, 3 (a pair of flat walls) opposed to each other, left and right opposite side walls 4, 5 interconnecting the upper and lower walls 2, 3 at left and right opposite side edges thereof, and a plurality of reinforcing walls 6 interconnecting the upper

and lower walls 2, 3, extending longitudinally of the tube and spaced from one another as positioned between the right and left side walls 4, 5, the tube having parallel fluid channels 7 formed inside thereof. Although not shown, each of the reinforcing walls 6 is provided with communication holes for causing each adjacent pair of fluid channels 7 to communicate with each other therethrough, the communication holes in the entire tube being in a staggered arrangement when seen from above.

The left side wall 4 comprises a side wall forming portion 9 projecting downward from the left side edge of the upper wall 2 integrally therewith and a side wall forming portion 10 projecting upward from the left side edge of the lower wall 3 integrally therewith, and is formed by causing these portions 9, 10 to butt against each other and brazing these portions in this state. The right side wall 5 is made integral with the upper and lower walls 2, 3.

The reinforcing walls 6 comprise reinforcing wall forming portions 11 projecting downward from the upper wall 2 integrally therewith and reinforcing wall forming portions 12 projecting upward from the lower wall 3 integrally therewith, and are formed by causing the wall portions 11 to butt against the corresponding wall portions 12 and brazing the corresponding pairs of wall portions 11, 12. The reinforcing wall forming portions 11 on one of the flat walls, i.e., the upper wall 2, have a larger thickness than the reinforcing walls 12 on the other flat wall, i.e., the lower wall 12. The thin reinforcing wall forming portions 11 will hereinafter be

referred to as the "first reinforcing wall forming portions," and the thick reinforcing wall forming portions 12 as the "second reinforcing wall forming portions."

As shown in FIG. 2, opposite side faces of the first reinforcing wall forming portion 11 are positioned inwardly of respective opposite side faces of the second reinforcing wall forming portion 12, and the opposite side portions of upper end face of the second reinforcing wall forming portion 12 project outward beyond the first wall portion 11. The center lines of the two reinforcing wall forming portions 11, 12 with respect to the direction of thickness thereof are preferably in alignment. A fillet 13 is formed between the opposed end faces of the first and second reinforcing wall forming portions 11, 12 and between opposite side edges of lower end face of the first wall portion 11 and the side edges of upper end face of the second wall portion 12.

The flat tube 1 is fabricated using a platelike body in the manner shown in FIG. 3.

The platelike body is made from an aluminum brazing sheet having a brazing material layer over opposite sides thereof by rolling. As shown in FIG. 3(a), the platelike body 15 comprises an upper wall forming portion 17 (flat wall forming portion) and a lower wall forming portion 18 (flat wall forming portion) which are flat for making the upper and lower walls 2, 3, a connecting portion 16 interconnecting the upper and lower wall forming portions 17, 18 integrally therewith for making the right side wall 5, side wall forming portions 9, 10 formed respectively on the upper wall forming portion 17

and the lower wall forming portion 18 integrally therewith and each projecting upward from one side edge thereof opposite to the connecting portion 16 for making the left side wall 4, and reinforcing wall forming portions 11, 12 projecting upward respectively from the upper wall forming portion 17 and the lower wall forming portion 18 integrally therewith and arranged at a spacing in the left-right direction. The first reinforcing wall forming portions 11 on the upper wall forming portion 17 and the second reinforcing wall forming portions 12 on the lower wall forming portion 18 are symmetrical about the vertical center line of the platelike body 15 with respect to the widthwise direction thereof.

The connecting portion 16 has a larger thickness than the upper and lower wall forming portions 17, 18. The side wall forming portions 9, 10 have a larger thickness than the first and second reinforcing wall forming portions 11, 12. The side wall forming portions 9, 10 have a height of projection which is approximately half of the width of the connecting portion 16.

The side wall forming portion 10 on the lower wall forming portion 18 is provided, at the center of width of its top end, with a ridge 19 extending longitudinally of the portion 10. On the other hand, the side wall forming portion 9 on the upper wall forming portion 17 is provided in its top end with a groove 20 extending longitudinally of the portion 9 for the ridge 19 to be forced in.

The first reinforcing wall forming portions 11 have a smaller thickness than the second reinforcing wall forming

portions 12. The first reinforcing wall forming portions 11 are preferably up to 0.5 mm, more preferably up to 0.35 mm, in thickness. The difference between the thickness of the first reinforcing wall forming portions 11 and that of the second reinforcing wall forming portions 12 is preferably at least 0.05 mm to not larger than 0.3 mm.

With the side wall forming portions 9, 10 and first and second reinforcing wall forming portions 11, 12 formed on one surface of an aluminum brazing sheet which is clad with a brazing material over opposite surfaces thereof, brazing material layers 21, 22 are formed on the top ends of the respective side wall forming portions 9, 10 and the respective first and second reinforcing wall forming portions 11, 12 (see FIG. 4), and a brazing material layer (not shown) is formed on both the upper and lower surfaces of the upper and lower wall forming portions 17, 18. The brazing material layers 21, 22 on the top ends of the side wall forming portions 9, 10 and on the first and second reinforcing wall forming portions 11, 12 have a larger thickness than the brazing material layer on the other portions. The ridge 19 and the groove 20 on or in the side wall forming portions 9, 10 are also formed when the aluminum brazing sheet is rolled. The top end face and opposite side faces of the ridge 19, and the bottom face and opposite side faces defining the groove 20 are also provided with the brazing material layer.

The platelike body 15 for making the flat tube is progressively bent at opposite sides of the connecting portion 16 [see FIG. 3(b)], and is finally bent into a hairpin form to butt the side wall forming portions 9, 10, as well as each

corresponding pair of portions 11, 12, against each other, force the ridge 19 into the groove 20 and obtain a folded body 23 [see FIG. 3(c)]. As this time, the top end face of each first reinforcing wall forming portion 11 comes into contact with the top end face of the corresponding second reinforcing wall forming portion 12, and the opposite side portions of the top end face of the second reinforcing wall forming portion 12 project outward beyond the first reinforcing wall forming portion 11 since opposite side faces of the first portion 11 are positioned inwardly of the opposite side faces of the second portion 12. The portions of the top end face of the second reinforcing wall forming portion 12 projecting outward beyond the first reinforcing wall forming portion 11 are indicated at 12a (see FIG. 4). In the folded body 23, the connecting portion 16 provides the right side wall 6, upper wall forming portion 17 provides the upper wall 2, and the lower wall forming portion 18 provides the lower wall 3.

The folded body 23 is thereafter heated to a predetermined temperature to braze the side wall forming portions 9, 10, as well as each corresponding pair of first and second reinforcing wall forming portions 11, 12, to each other utilizing the above-mentioned brazing material layers and to thereby form of the left side wall 4 and the reinforcing walls 6. At this time, a fillet 13 is formed between the opposed inner end faces of the first and second reinforcing wall forming portions 11, 12 and between opposite side edges of inner end face of the first wall portion 11 and the side edges of inner end face of the second wall portion 12 as described above. In this

way, a flat tube 1 is fabricated.

When the flat tube 1 is to be used, for example, as the refrigerant tube 52 of the condenser shown in FIG. 13, such flat tubes 1 may be produced simultaneously with the fabrication of the condenser. More specifically, the condenser is fabricated in the following manner. First prepared are a plurality of folded bodies 23. Also prepared are a pair of aluminum headers 50, 51 each having folded body inserting holes, and a plurality of corrugated aluminum fins 53. The pair of headers 50, 51 are then arranged as spaced apart, the folded bodies 23 and the fins 53 are arranged alternately, and opposite ends of the folded bodies 23 are inserted into the respective inserting holes of the headers 50, 51. The resulting assembly is thereafter heated at a predetermined temperature to braze the two side wall forming portions 9, 10, as well as each corresponding pair of reinforcing wall forming portions 11, 12, of each folded body 23 to each other to make flat tubes 1. At the same time, the flat tubes 1 are brazed to the headers 50, 51, and each of the corrugated fins 53 is brazed to the flat tubes 1 adjacent thereto. The brazing material layers of the flat tube making platelike bodies 15 are used for brazing. In this way, the condenser is fabricated.

FIG. 5 shows another embodiment.

In the case of the flat tube 30 of this embodiment, an upper wall 2 and a lower all 3 are each provided with thin first reinforcing wall forming portions 11 and thick reinforcing wall forming portion 12 which are arranged alternately. The first reinforcing wall portion 11 of the upper wall 2 and the

second reinforcing wall portion 12 of the lower wall 3 are butted against each other. The second reinforcing wall forming portion 12 of the upper wall 2 and the first reinforcing wall forming portion 11 of the lower wall 3 are butted against each other. With the exception of these features, the tube 30 has the same construction as the tube 1 shown in FIG. 1. Opposite side faces of the first portion 11 position inwardly of the opposite side faces of the second portion 12, and opposite side portions of end face of the second portion 12 project outward beyond the first portion 11. A fillet 13 is formed between opposed end faces of the two portions 11, 12, and between opposite side edges of end face of the first portion 11 and opposite side edges of end face of the second portion 12.

The flat tube 30 shown in FIG. 5 is fabricated from a platelike body 31 shown in FIG. 6. The flat tube making platelike body 31 has an upper wall forming portion 17 which is integrally provided with first reinforcing wall forming portions 11 and second reinforcing wall forming portions 12 arranged alternately in the left-right direction at a predetermined spacing. The platelike body 31 has a lower wall forming portion 18 which is integrally provided with first reinforcing wall forming portions 11 and second reinforcing wall forming portions 12 arranged alternately in the left-right direction at a predetermined spacing. The first portions 11 of the upper wall forming portion 17 and the second portions 12 of the lower wall froming portion 18, as well as the second portions 12 of the upper wall forming portion 17 and the first portions 11 of the lower wall forming portions 18, are positioned

symmetrically about a center line with respect to the widthwise direction.

With the exception of these features, the platelike body 31 is the same as the platelike body 15 shown in FIG. 3(a), and the flat tube 30 is fabricated by the same process as is shown in FIG. 3.

FIGS. 7 and 8 show another embodiment of flat tube.

In the case of the flat tube 35 of this embodiment, a thick second reinforcing wall forming portion 12 is provided in the end face thereof with a groove 36 extending longitudinally thereof for fitting therein the end of a thin first reinforcing wall forming portion 11 to be butted against the portion 12. The end of the thin first portion 11 is forced into the groove 36 of the second portion 12 by a press fit, and the end face and opposite side faces of the end of the first portion 11 are brazed to the bottom wall and opposite side faces of the second portion 12 defining the groove 36 thereof. Further as shown in FIG. 8, a fillet 13 is formed between the end face of the first portion 11 and the bottom wall defining the groove 36 of the second portion 12 and between opposite side faces of the first portion 11 positioned outside the groove 36 and opposite side edges of end face of the second portion 12. With the end face and opposite side faces of the end of the first portion 11 brazed to the bottom wall and side faces of the groove 36 of the second portion 12, the area of brazing joint between the two reinforcing wall forming portions 11, 12 are greater than is shown in FIG. 2, hence an enhanced brazing joint strength.

With the exception of these features, the flat tube 35 is the same as the flat tube 30 shown in FIG. 5.

The flat tube 35 shown in FIGS. 7 and 8 are fabricated from a platelike body 37 shown in FIGS. 9 and 10. The platelike body 37 has an upper wall forming portion 17 and a lower wall forming portion 18 each provided with first reinforcing wall forming portions 11 which are tapered, i.e., having reducing thickness toward an end. These portion s17, 18 have second reinforcing wall forming portions 12 each having a groove 36 formed in the end face thereof and extending over the entire length thereof. Opposite side faces defining the groove are vertical. As shown in FIG. 10, a brazing material layer 22 is formed on opposite side portions of the groove 36 in the end face of the second reinforcing wall forming portion 12 and on the bottom wall defining the groove 36.

With the exception of these features, the platelike body 37 is the same as the body 31 shown in FIG. 6, and the flat tube 35 is fabricated by the same process as shown in FIG. 3.

With the flat tube 35 shown in FIGS. 7 and 8, first reinforcing wall forming portions 11 only may be formed on the upper wall 2, i.e., on one of the flat walls, and second reinforcing wall forming portions 12 only may be formed on the lower wall 3, i.e., on the other flat wall, as is the case with the flat tube 1 shown in FIG. 1.

FIG. 11 shows a modification of first and second reinforcing wall forming portions 11, 12 of flat tube making platelike body.

With reference to FIG. 11(a), the illustrated lower end face of a first reinforcing wall forming portion 11 is integrally provided at the midportion of width thereof with a ridge 40 extending longitudinally of the portion 11, and a second reinforcing wall forming portion 12 is provided in its illustrated upper end face with a groove 41 extending longitudinally of the portion 12 for the ridge 40 to fit in. The ridge 40 has a generally semicircular cross sectional outer periphery and a lower portion covered with a brazing material layer 22. The groove 41 has a generally semicircular cross sectional inner periphery which is not covered with a brazing material layer 22. The portion of the brazing material layer 21 covering the ridge 40 is fitted in the groove 41 intimately.

When this platelike body having such first and second reinforcing wall forming portions 11, 12 is used for making a flat tube by the same process as shown in FIG. 3, a fillet 13 is formed between opposed end faces of the two reinforcing wall forming portions 11, 12 and between opposite side edges of lower end face of the first reinforcing wall forming portion 11 and opposite side edges of upper end face of the second reinforcing wall forming portion 12 as shown in FIG. 11(b). The provision of the ridge 40 and the groove 41 results in a greater brazing area between the two portions 11, 12 than in the case shown in FIG. 2 and therefore a greater brazing joint strength.

FIG. 12 shows another modification of first and second reinforcing wall forming portions 11, 12 of flat tube making

platelike body.

With reference to FIG. 12(a), a first reinforcing wall forming portion 11 has a lower end face bulging downward in a circular-arc form in cross section. The illustrated upper end face of a second reinforcing wall forming portion 12 is provided, at the midportion of width thereof, with a groove 45 extending longitudinally of the portion 12. The upper end face of the second portion 12 has on opposite sides of the groove 45 portions each bulging upward in an circular-arc form in cross section. The groove 45 has a slightly larger width than the side portions thereof and a flat bottom face. The inner peripheral surface defining the groove 45 is entirely covered with a brazing material layer 22.

When a flat tube is fabricated by the same process as shown in FIG. 3 from the platelike body having such first and second reinforcing wall forming portions 11, 12, a fillet 13 is formed between opposed end faces of the two reinforcing wall forming portions 11, 12 and between opposite side edges of lower end face of the first reinforcing wall forming portion 11 and opposite side edges of upper end face of the second reinforcing wall forming portion 12 as shown in FIG. 12(b). The lower end face of the first reinforcing wall forming portion 11 bulges downward in a circular-arc form in cross section, the groove 45 is formed in the second reinforcing wall forming portion 12, and the upper end face of the second reinforcing wall forming portion 12 has on opposite sides of the groove 45 portions each bulging upward in an circular-arc form in cross section, whereby the brazing joint area between the two

portions 11, 12 is made greater than is shown in FIG. 2 to result in a greater brazing joint strength.

The first and second reinforcing wall forming portions 11, 12 shown in FIGS. 11 and 12 are available in two modes; as shown in FIG. 3(a), first reinforcing wall forming portions 11 are provided on one of the flat wall forming portions, with second reinforcing wall forming portions 12 provided on the other flat wall forming portion, or as shown in FIG. 6, first and second reinforcing wall forming portions are provided alternately on each of the flat wall forming portions.

The heat exchanger comprising flat tubes fabricated from the platelike body described is used in vehicles, e.g., motor vehicles, equipped with a refrigeration cycle which comprises a compressor, condenser, evaporator and pressure reducing device and wherein a chlorofluorocarbon refrigerant is used, as the condenser of the cycle, or as the evaporator thereof.

Further the flat tube fabricated from the platelike body described may be used in vehicles, e.g., motor vehicles, equipped with an air conditioner which comprises a compressor, gas cooler, evaporator, pressure reducing means and an intermediate heat exchanger for subjecting to heat exchange the refrigerant flowing out of the gas cooler and the refrigerant flowing out of the evaporator, and wherein CO_2 refrigerant or like supercritical refrigerant is used, as the heat exchange tube for the gas cooler or evaporator for the air conditioner.

INDUSTRIAL APPLICABILITY

The flat tube making platelike body of the invention is

useful for making flat tubes for use as heat exchange tubes for heat exchangers, such as refrigerant tubes in condensers or evaporators for motor vehicle air conditioners, oil tubes for motor vehicle oil coolers, water tubes for motor vehicle radiators and heat medium tubes for heater cores.